FINAL ACTION

Response to Amendment

1. Applicant's amendment of 06/17/2009 does not place the Application in condition for allowance.

2. Claims 1-6, 8 and 10-11 are currently pending. Applicant has amended claims 1-2, 5-6 and 8, and cancelled claims 7 and 9.

Status of the Objections or Rejections

3. The rejections of claims 1-6, 8 and 10-11 from the office Action dated 04/14/2009 are withdrawn in view of applicant's amendments to the claims. However, upon further consideration, a new ground of rejection is presented below.

Claim Rejections - 35 USC § 102

4. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

5. Claims 1-3 are rejected under 35 U.S.C. 102(b) as being anticipated by Nakai et al. (US 6,207,890 B1).

Regarding claim 1, Nakai discloses a photovoltaic element (see fig. 11 and col. 1, lines 6-8), which reads on instant photoelectric conversion device, comprising: an intrinsic-type amorphous silicon layer (2), which reads on instant first conductivity type semiconductor substrate (2), having convex and concave portions (as shown in fig. 11) formed on its surface (se fig. 11 for configuration), the device comprising at least:

- a p-type amorphous silicon layer (3), which reads on instant second conductivity type semiconductor layer, formed being in direct contact with the intrinsic-type amorphous silicon layer (2) (see fig. 11), without any intervening layers therebetween;
- a front electrode (4) connected to the p-type amorphous silicon layer (3);
- a back/rear electrode (6) formed on the rear surface of the intrinsic-type amorphous silicon layer (2),
- the p-type amorphous silicon layer (3) being in direct physical contact with the front electrode (4) and becoming thinner as it goes farther from the contacted area (layer 3 becomes thickest at the peak, i.e., convex portion and thins out at it goes away from the peak; see fig. 11 and also col. 2, lines 2-11), and wherein the p-type amorphous silicon layer (3) has the convex and concave portions (see fig. 11 for configuration) along the convex and concave portions of the intrinsic-type semiconductor layer (2), respectively.

Claim 1 is product-by-process claim, and therefore the claim is not limited to the manipulation of the recited method of forming the second conductive type semiconductor layer by implanting second conductivity type impurities into the surface of the first conductivity type semiconductor substrate (MPEP §2113; and *In re Thorpe*, 777F.2d 695, 698, 227 USPQ 964,966 (Fed. Cir. 1985)).

In addition, although the claim requires a partial direct physical contact between the front electrode and the second conductivity type semiconductor layer, the claim does not preclude the layers being in full contact, and therefore the claim is anticipated.

Regarding claim 2, Nakai further discloses that the convex portions of the semiconductor substrate (2) are arranged at given intervals (as shown in Figure 11) and the second conductivity type semiconductor layer becomes (3) thinner from the top of the convex portions (peak) (see fig. 11) to the concave portions (trough) (see fig. 11) of the substrate (2) (col. 2, lines 5-9).

Regarding claim 3, Nakai further discloses that each convex portion has the comb-like electrode (5) (as shown in Figure 11) (col. 1, lines 47-48).

Claim Rejections - 35 USC § 103

6. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

7. Claims 1-3 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakai et al. (US 6,207,890 B1) in view of Tsuzuki et al. (US 6,184,457 B1).

Regarding claim 1, Nakai discloses a photovoltaic element (see fig. 11 and col. 1, lines 6-8), which reads on instant photoelectric conversion device, comprising: an intrinsic-type amorphous silicon layer (2), which reads on instant first conductivity type semiconductor substrate (2+3), having convex and concave portions (as shown in fig. 11) formed on its surface (se fig. 11 for configuration), the device comprising at least:

- a p-type amorphous silicon layer (3), which reads on instant second conductivity type semiconductor layer, formed being in direct contact with the intrinsic-type amorphous silicon layer (2) (see fig. 11), without any intervening layer therebetween;

- a comb-like collecting electrode (5), which reads on instant front electrode, connected to the p-type amorphous silicon layer (3);
- a back/rear electrode (6) formed on the rear surface of the intrinsic-type amorphous silicon layer (2),
- the p-type amorphous silicon layer (3) being in partially contact with the comb-like collecting electrode (5) and becoming thinner as it goes farther from the contacted area (layer 3 becomes thickest at the peak, i.e., convex portion and thins out at it goes away from the peak; see fig. 11 and also col. 2, lines 2-11), and wherein the p-type amorphous silicon layer (3) has the convex and concave portions (see fig. 11 for configuration) along the convex and concave portions of the intrinsic-type semiconductor layer (2), respectively.

Claim 1 is product-by-process claim, and therefore the claim is not limited to the manipulation of the recited method of forming the second conductive type semiconductor layer by implanting second conductivity type impurities into the surface of the first conductivity type semiconductor substrate (MPEP §2113; and *In re Thorpe*, 777F.2d 695, 698, 227 USPQ 964,966 (Fed. Cir. 1985)).

Although Nakai shows that the comb-like collecting electrode (5) is in partial contact with the p-type amorphous semiconductor layer (3), the reference is silent as to direct physical contact.

Tsuzuki teaches a photovoltaic device (see fig. 9) wherein the collector electrode (804) is partially in direct physical contact with the semiconductor layer (802).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have made the comb-like collecting electrode (5) of Nakai partially in direct physical contact with the p-type amorphous silicon layer (3) of Nakai, as taught by Tsuzuki, because doing so only predictable results of directly collecting the current generated by p-i-n junction would have been achieved.

Regarding claim 2, Nakai in view of Tsuzuki further discloses that the convex portions of the semiconductor substrate (2) are arranged at given intervals (as shown in figure 11) and the second conductivity type semiconductor layer becomes (3) thinner from the top of the convex portions (peak) (see fig. 11) to the concave portions (trough) (see fig. 11) of the substrate (2) (col. 2, lines 5-9).

Regarding claim 3, Nakai further discloses that each convex portion has the comb-like electrode (5) (as shown in Figure 11) (col. 1, lines 47-48).

Regarding claim 10, Nakai in view of Tsuzuki further discloses that the partial contact between the second conductivity type semiconductor layer (3) and the comb-like connecting electrode (5) is substantially a point (see fig. 11 of Nakai which shows a substantially point partial contact as shown in the instant application in fig. 2, therefore it is Examiner's position that the partial contact is substantially point).

8. Claims 1-3 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakai et al. (US 6,207,890 B1) in view of Nino et al. (US 5,514,217 A), and further in view of Tsuzuki et al. (US 6,184,457 B1).

Regarding claim 1, Nakai discloses a photovoltaic element (see fig. 11 and col. 1, lines 6-8), which reads on instant photoelectric conversion device, comprising: an

intrinsic-type amorphous silicon layer (2), which reads on instant first conductivity type semiconductor substrate (2+3), having convex and concave portions (as shown in fig. 11) formed on its surface (se fig. 11 for configuration), the device comprising at least:

- a p-type amorphous silicon layer (3), which reads on instant second conductivity type semiconductor layer, formed being in direct contact with the intrinsic-type amorphous silicon layer (2) (see fig. 11), without any intervening layer therebetween;
- a comb-like collecting electrode (5), which reads on instant front electrode, connected to the p-type amorphous silicon layer (3);
- a back/rear electrode (6) formed on the rear surface of the intrinsic-type amorphous silicon layer (2),
- the p-type amorphous silicon layer (3) being in partially contact with the comb-like collecting electrode (5) and becoming thinner as it goes farther from the contacted area (layer 3 becomes thickest at the peak, i.e., convex portion and thins out at it goes away from the peak; see fig. 11 and also col. 2, lines 2-11), and wherein the p-type amorphous silicon layer (3) has the convex and concave portions (see fig. 11 for configuration) along the convex and concave portions of the intrinsic-type semiconductor layer (2), respectively.

Although the reference shows the formation of p-type amorphous silicon layer (3) in direct contact with the intrinsic-type amorphous silicon layer (2) (see fig. 11), without any intervening layer therebetween, the reference is silent as to whether the p-type

amorphous silicon layer (3) is formed by implanting p-type impurities into the surface of the intrinsic-type semiconductor layer (2).

However, it well known in the semiconductor art to implant p-type dopant into the i-type semiconductor layer to obtain p-type semiconductor layer, as shown by Nino (col. 50, lines 3-7).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have formed the p-type layer of Nakai by implanting p-type dopant into i-type layer as shown by Nino, because doing so only predictable results of formation of p-type semiconductor layer would have achieved, as shown by Nino.

Although Nakai in view of Nino shows that the comb-like collecting electrode (5) is in partial contact with the p-type amorphous semiconductor layer (3), the reference is silent as to direct physical contact.

Tsuzuki teaches a photovoltaic device (see fig. 9) wherein the collector electrode (804) is partially in direct physical contact with the semiconductor layer (802).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have made the comb-like collecting electrode (5) of Nakai partially in direct physical contact with the p-type amorphous silicon layer (3) of Nakai, as taught by Tsuzuki, because doing so only predictable results of directly collecting the current generated by p-i-n junction would have been achieved.

Regarding claim 2, Nakai further discloses that the convex portions of the semiconductor substrate (2) are arranged at given intervals (as shown in Figure 11) and the second conductivity type semiconductor layer becomes (3) thinner from the top of

the convex portions (peak) (see fig. 11) to the concave portions (trough) (see fig. 11) of the substrate (2) (col. 2, lines 5-9).

Regarding claim 3, Nakai further discloses that each convex portion has the comb-like electrode (5) (as shown in Figure 11) (col. 1, lines 47-48).

Regarding claim 10, Nakai in view of Nino and Tsuzuki further discloses that the partial contact between the second conductivity type semiconductor layer (3) and the comb-like connecting electrode (5) is substantially a point (see fig. 11 of Nakai which shows a substantially point partial contact as shown in the instant application in fig. 2, therefore it is Examiner's position that the partial contact is substantially point).

9. Claims 1-3 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakai et al. (US 6,207,890 B1) in view of Nino et al. (US 5,514,217 A).

Regarding claim 1, Nakai discloses a photovoltaic element (see fig. 11 and col. 1, lines 6-8), which reads on instant photoelectric conversion device, comprising: an intrinsic-type amorphous silicon layer (2), which reads on instant first conductivity type semiconductor substrate (2), having convex and concave portions (as shown in fig. 11) formed on its surface (se fig. 11 for configuration), the device comprising at least:

- a p-type amorphous silicon layer (3), which reads on instant second conductivity type semiconductor layer, formed being in direct contact with the intrinsic-type amorphous silicon layer (2) (see fig. 11), without any intervening layers therebetween;
- a front electrode (4) connected to the p-type amorphous silicon layer (3);

- a back/rear electrode (6) formed on the rear surface of the intrinsic-type amorphous silicon layer (2),
- the p-type amorphous silicon layer (3) being in direct physical contact with the front electrode (4) and becoming thinner as it goes farther from the contacted area (layer 3 becomes thickest at the peak, i.e., convex portion and thins out at it goes away from the peak; see fig. 11 and also col. 2, lines 2-11), and wherein the p-type amorphous silicon layer (3) has the convex and concave portions (see fig. 11 for configuration) along the convex and concave portions of the intrinsic-type semiconductor layer (2), respectively.

Although the claim requires a partial direct physical contact between the front electrode and the second conductivity type semiconductor layer, the claim does not preclude the layers being in full contact, and therefore the claim is anticipated.

In addition, though the reference shows the formation of p-type amorphous silicon layer (3) in direct contact with the intrinsic-type amorphous silicon layer (2) (fig. 11), without any intervening layer therebetween, the reference is silent as to whether the p-type amorphous silicon layer (3) is formed by implanting p-type impurities into the surface of the intrinsic-type semiconductor layer (2).

However, it well known in the semiconductor art to implant p-type dopant into the i-type semiconductor layer to obtain p-type semiconductor layer, as shown by Nino (col. 50, lines 3-7).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have formed the p-type layer of Nakai by implanting p-type

dopant into i-type layer as shown by Nino, because doing so only predictable results of formation of p-type semiconductor layer would have achieved, as shown by Nino.

Regarding claim 2, Nakai further discloses that the convex portions of the semiconductor substrate (2) are arranged at given intervals (as shown in Figure 11) and the second conductivity type semiconductor layer becomes (3) thinner from the top of the convex portions (peak) (see fig. 11) to the concave portions (trough) (see fig. 11) of the substrate (2) (col. 2, lines 5-9).

Regarding claim 3, Nakai further discloses that each convex portion has the comb-like electrode (5) (as shown in Figure 11) (col. 1, lines 47-48).

10. Claims 1, 4, 5, 8 and 10-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schmidt (US 4,577,393) in view of Okamoto et al. (JP 04-356972A) and further in view of collective teachings of Matsuyama et al. (US 6,072,117) and Nakayama (US 5,620,530).

Regarding claim 1, Schmidt discloses a solar cell (fig. 7 and col. 3, line 15 to col. 4, line 30), which reads on instant photoelectric conversion device, using a p-type semiconductor body (1), which reads on instant first conductivity type semiconductor substrate, the solar cell comprising at least: an n-type semiconductor zone (4), which reads on instant second conductivity type semiconductor layer, formed by implant n-type impurities into surface of the p-type semiconductor body (1) (col. 4, lines 3-10) and being in direct contact with the p-type semiconductor body (1) (see fig. 1 and col. 4, lines 21-30); a front side contact (7), which reads on instant front electrode, connected to the n-type semiconductor zone (4) (fig. 1); a rear side contact (8), which reads on

instant rear electrode, formed on the rear surface of the p-type semiconductor body (1) (fig. 1), the n-type semiconductor zone (4) being partially in direct physical contact with the front side contact (7) to created a contacted area (col. 3, line 15 to col. 4, line 30).

However, the reference is silent as to the convex and concave portions formed on the surface of the semiconductor substrate, and whether the second conductivity type layer becomes thinner as it goes away from the contacted area.

Okamoto discloses a photoelectric conversion device (fig. 1 and [0018-0025]) using a first conductivity type (P-type) semiconductor substrate (P-type semiconductor substrate 10) having convex (peak) and concave (trough) portions (as shown in fig. 1) formed on its surface (fig. 1 shows formation of convex (peak) and concave (trough) portion on the upper surface of the substrate 10), the device comprising at least: a second conductivity type semiconductor layer (N-type semiconductor layer 1) formed by implant second conductivity type impurities into the surface of the first conductivity type semiconductor substrate (10) and being in direct contact with the first conductivity type semiconductor substrate (10) (see fig. 1 and [0018]); a front electrode (collecting electrode 5) connected to the second conductivity type semiconductor layer (1) (fig. 1); a rear electrode (rear-surface electrode 6) formed on the rear surface of the first conductivity type semiconductor substrate (10) (fig. 1), the second conductivity type semiconductor layer (1) being partially in direct physical contact with the front electrode (5) and becoming thinner as it goes farther from the contacted area (layer 1 becomes thickest at the concave portion and thins out at it goes away from the concave portion to the convex portion, see fig. 1).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have utilized the teachings of Okamoto in the photoelectric conversion device of Schmidt to form the convex and concave portions on the surface of the semiconductor substrate in the photoelectric conversion device of Schmidt and also to make the second conductivity type layer of Schmidt becoming thinner as it goes farther from the contacted area as taught Okamoto such that series resistance is reduced (see [0019] of Okamoto).

However, the references are silent as to whether the second conductivity layer has the convex and concave portions along the convex the concave portions of the first conductivity type semiconductor substrate, respectively,

Matsuyama discloses a photoelectric conversion device wherein the semiconductor substrate (104) has convex and concave portions and the successive semiconductor layers (105 and 106) also has convex and concave portions along the convex and concave portions of the semiconductor substrate (104) (see fig. 1, 7:18-47, 20:56-61) in order to allow for a device which possesses increased photoelectric conversion efficiency. Nakayama also discloses that the use of convex and concave portions in the semiconductor layers enhance the effect of light trapping (20:66-21:12), and therefore increase the photoelectric conversion efficiency.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have utilized the teachings of Matsuyama and Nakayama in the photoelectric conversion device of Schmidt in view of Okamoto to form concave and convex portions on the surface of the second conductivity type layer along convex and

concave portions of the p-type semiconductor body such that the effect of light trapping is enhanced, and thereby increase in the photoelectric conversion efficiency is achieved, as taught by collective teachings of Matsuyama and Nakayama.

Regarding claim 4, Schmidt in view of Okamoto further discloses that the convex portions (peak) of the semiconductor substrate are arranged at given intervals (as shown in Figure 1 of Okamoto) and the second conductivity type semiconductor layer becomes thicker from the top of the convex portions (peak) to the concave portions (trough) of the substrate (see fig. 1 of Okamoto) ([0018-0019]).

Regarding claim 5, Schmidt in view of Okamoto further discloses that each concave portion has the front electrode (as shown in fig. 1 of Okamoto).

Regarding claim 8, Schmidt discloses a method for manufacturing a solar cell (fig. 7 and col. 3, line 15 to col. 4, line 30), which reads on instant photoelectric conversion device, comprising:

(a). forming a doping film (2) containing n-type impurities (which reads on instant second conductivity type impurities) on a p-type semiconductor body (1), which reads on instant first conductivity type semiconductor substrate;

(b). forming n-type type impurities into surface of the p-type semiconductor body (1) (col. 4, lines 3-10) from the film (2) to form an n-type semiconductor zone, which reads on instant second conductivity type semiconductor layer, and

(c). forming a front side contact (7), which reads on instant front electrode, that is in partial direct physical contact with a part of the semiconductor substrate surface (front electrode 7 is in direct contact with layer 4 and since layer 4 is

formed into the surface of the substrate, therefore, front electrode 7 is in direct physical contact with a part of the semiconductor substrate surface).

However, the reference is silent as to the convex and concave portions formed on the surface of the semiconductor substrate, and whether the film and second conductivity type layer becomes thinner as it goes away from the contacted area.

Okamoto discloses a method of manufacturing a photoelectric conversion device (fig. 1 and [0018-0025]) using a first conductivity type (P-type) semiconductor substrate (P-type semiconductor substrate 10) having convex (peak) and concave (trough) portions (as shown in fig. 1) formed on its surface (fig. 1 shows formation of convex (peak) and concave (trough) portion on the upper surface of the substrate (10). Okamoto further discloses the method of forming a second conductivity type (N-type) impurity layer wherein the layer becomes thicker from convex to concave portions (see fig. 1).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have utilized the teachings of Okamoto in the method of Schmidt to form the convex and concave portions on the surface of the semiconductor substrate and also to make the second conductivity type layer becoming thicker from the convex to concave portions as taught Okamoto such that series resistance is reduced (see [0019] of Okamoto).

However, the references are silent as to whether the second conductivity layer has the convex and concave portions along the convex the concave portions of the first conductivity type semiconductor substrate, respectively.

Matsuyama discloses a method of making a photoelectric conversion device wherein the semiconductor substrate (104) has convex and concave portions and the successive semiconductor layers (105 and 106) also has convex and concave portions along the convex and concave portions of the semiconductor substrate (104) (see fig. 1, 7:18-47, 20:56-61) in order to allow for a device which possesses increased photoelectric conversion efficiency. Nakayama also discloses that the use of convex and concave portions in the semiconductor layers enhance the effect of light trapping (20:66-21:12), and therefore increase the photoelectric conversion efficiency.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have utilized the teachings of Matsuyama and Nakayama in the method of Schmidt in view of Okamoto to form concave and convex portions on the surface of the second conductivity type layer along convex and concave portions of the p-type semiconductor body such that the effect of light trapping is enhanced, and thereby increase in the photoelectric conversion efficiency is achieved, as taught by collective teachings of Matsuyama and Nakayama.

Regarding claim 10, Applicant is directed above for complete discussion of Schmidt in view of Okamoto with respect to claim 1, which is incorporated herein. Fig. 1 of Okamoto depicts that the partial contact between the second conductivity type semiconductor layer and the front electrode is substantially a point (see fig. 1 of Okamoto which shows a substantially point partial contact as shown in the instant application in fig. 2, therefore it is Examiner’s position that the partial contact is substantially point). In an alternative, it would have been obvious to one of ordinary skill

in the art at the time of the invention to form the front electrode of Schmidt in view of Okamoto in any desired shape such that the current collection can be optimized (since front electrode acts as the current collecting electrode), as desired by Schmidt in view of Okamoto. In addition, the configuration of the front electrode is a matter of choice which a person of ordinary skill in the art would have found obvious absent persuasive evidence that the particular configuration of the claimed front electrode is significant and would provide a distinct photoelectric conversion device (*In re Dailey*, 357 F.2d 669, 149 USPQ 47 (CCPA 1966)).

Regarding claim 11, Applicant is directed above for complete discussion of Schmidt in view of Okamoto with respect to claim 1, which is incorporated herein. One reading Schmidt in view of Okamoto as a whole would have readily appreciated that the front electrode of Schmidt in view of Okamoto can have any desired shape. However, the reference is silent as to whether the partial contact between the second conductivity type semiconductor layer and the front electrode is a straight line.

Matsuyama teaches a photoelectric conversion device wherein the front electrode (108) (fig. 1) is linearly arranged on the semiconductor layers.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have utilized the linear front electrode of the Matsuyama as the front electrode in the photoelectric conversion device of Schmidt in view of Okamoto, because doing so only predictable results of current collection would have been achieved, as shown by Matsuyama and also desired by Schmidt in view of Okamoto (since front electrode Schmidt in view of Okamoto acts as the current collecting

electrode). In addition, the configuration of the front electrode is a matter of choice which a person of ordinary skill in the art would have found obvious absent persuasive evidence that the particular configuration of the claimed front electrode is significant and would provide a distinct photoelectric conversion device (*In re Dailey*, 357 F.2d 669, 149 USPQ 47 (CCPA 1966)).

11. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Schmidt (US 4,577,393) in view of Uematsu et al. (US 4,916,503) and Okamoto et al. (JP 04-356972A), and further in view of collective teachings of Matsuyama et al. (US 6,072,117) and Nakayama (US 5,620,530).

Schmidt a method for manufacturing a photoelectric conversion device (see figs. 1-7; c3:15-4:30) comprising:

(a) forming a doping film (2) comprising liquid coating solution (see 3:39-56), which reads on instant film serving a barrier against impurity diffusion, on a p-type semiconductor body (1), which reads on instant first conductivity type semiconductor substrate,

(b) implanting n-type impurities into the semiconductor substrate (1) through the film (2) to form an n-type semiconductor zone (4) (4:2-10), and

(c) forming a front side contact (7), which reads on instant front electrode, that is in partial direct physical contact with a part of the semiconductor substrate surface (front electrode 7 is in direct contact with layer 4 and since layer 4 is formed into the surface of the substrate, therefore, front electrode 7 is in direct physical contact with a part of the semiconductor substrate surface).

However the reference is silent as to whether the substrate has convex and concave portions formed on its surface in such a manner that the film becomes thicker from the convex portion to the concave portion. The reference is silent as to whether the second conductivity type film becomes thinner from the convex to the concave portion of the surface of the semiconductor substrate.

Uematsu discloses a photoelectric conversion device (embodiment 4, fig. 11, and 7:40-51) wherein the p-type semiconductor base/substrate (11) has convex and concave portions formed on its surface (see fig. 11). Uematsu further discloses that the front electrode (electrode 113) is formed on the convex portion which constitutes a part of the semiconductor substrate surface (see fig. 11 of Uematsu).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have utilized the teaching of Uematsu in the method of Schmidt to form convex and concave portions on the surface of the semiconductor and also to the form the front electron on the convex portion in order to allow photoelectric conversion device which possesses improved photoelectric converting efficiency, as taught by Uematsu (see Abstract).

Since the semiconductor substrate (1) of Schmidt as modified by Uematsu has convex and concave portions formed on its surface, and the barrier film (2) of Schmidt comprises coating solution (see 3:39-56 of Schmidt) as in the case the instant invention (see page 11, line 23 - page 12, line 7), the film (2) inherently becomes thicker from the convex portion to the concave portion as the coating solution remains easily in the concave portions.

However, the references are silent as to whether the thickness of the second conductivity type semiconductor layer becomes thinner from the convex portions to the concave portions.

Okamoto discloses a method of making a photoelectric conversion device wherein the thickness of the second conductivity type semiconductor layer (1) changes in a manner such that the thickness of the layer is decreased in the area in which collecting electrodes are not present ([0023]) in order to reduce series resistance and increase short-circuit current.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have utilized the teachings of Okamoto in the method of Schmidt in view of Uematsu to increase the thickness of the second conductivity type semiconductor layer at the convex portion, since the collecting electrode is present at the convex portion, and to reduce the thickness in the concave area which does not comprise any concave portion, such that series resistance is reduced and short-circuit current is increased.

However, the references are silent as to whether the second conductivity layer has the convex and concave portions along the convex the concave portions of the first conductivity type semiconductor substrate, respectively,

Matsuyama discloses a photoelectric conversion device wherein the semiconductor substrate (104) has convex and concave portions and the successive semiconductor layers (105 and 106) also has convex and concave portions along the convex and concave portions of the semiconductor substrate (104) (see fig. 1, 7:18-47,

20:56-61) in order to allow for a device which possesses increased photoelectric conversion efficiency. Nakayama also discloses that the use of convex and concave portions in the semiconductor layers enhance the effect of light trapping (20:66-21:12), and therefore increase the photoelectric conversion efficiency.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have utilized the teachings of Matsuyama and Nakayama in the method of Schmidt in view of Uematsu and Okamoto to form concave and convex portions on the surface of the second conductivity type layer along convex and concave portions of the p-type semiconductor body such that the effect of light trapping is enhanced, and thereby increase in the photoelectric conversion efficiency is achieved, as taught by collective teachings of Matsuyama and Nakayama.

Response to Arguments

12. Applicant's arguments with respect to claims 1-6, 8 and 10-11 have been considered but are moot in view of the new ground(s) of rejection as necessitated by the amendments.

Conclusion

13. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within

TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Correspondence/Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to GOLAM MOWLA whose telephone number is (571) 270-5268. The examiner can normally be reached on M-F, 0900-1700 EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, JENNIFER MICHENER can be reached on (571) 272-1424 until Dec 31, 2009, or ALEXA NECKEL can be reached on (571) 272-1446 from January 2009, onwards. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a

USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/G. M./
Examiner, Art Unit 1795
/Jennifer K. Michener/
Supervisory Patent Examiner, Art Unit 1795